bring us into closer accord, at the risk of taking up too much space from an indulgent Editor. My purpose is not only to make quantitative predictions, but also to enhance understanding of the mechanism of glacier variations. This latter purpose is best achieved by making judicious simplifications. For the quantitative predictions I refer Dr. Shumskiy to the later papers of the series.

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SIR, *Water-spouts on the Britannia Gletscher, north-east Greenland**

Wiseman's (1963) letter to this *Journal* describing a water-spout on the Aletsch Gletscher reminded me of the water-spouts encountered by members of the British North Greenland Expedition (Simpson, 1955) near the snout of the Britannia Gletscher in the summer of 1954, and prompted me to exhume two photographs from my files (Figs. 1 and 2). These water-spouts were not intermittent like those described by Wiseman (1963) and Rucklidge (1956), but were continuous gushers lasting for several days, and forming an integral part of the drainage pattern of the glacier. They are thus more akin to the spouts described by Glen (1941), who stressed the role of crevasses in englacial and subglacial drainage and stated that sometimes the water carried in this way from higher levels "attains such a pressure that it literally bursts its way through the ice, sending up a small water-spout which may continue for as along as an hour, then dying down into a more gentle fountain".

The Britannia Gletscher in Dronning Louise Land is about 14 km. long and 8 km. wide, with a snout fanning out in piedmont fashion (now much reduced). The eastern side of the glacier flows into Britannia Sø. A detailed map of the glacier and its environs is given in the account by Hamilton and others (1956) of the expedition's research, and in a paper by Lister and Wyllie (1958) there is a good view (fig. 24) of the lower part of the glacier photographed from a vantage point 500 m. above it. The map and the photograph show a well-defined radial drainage pattern, with many melt-water streams deeply incised. Roughly concentric with the snout of the glacier, and transverse to the radial drainage, there is a series of markings on the surface which appear at close quarters to be small scarps, with dip slope down-glacier. Small features of this kind are visible in Figure 1, trending from lower right to upper left of the picture. These are probably the surface expression of shear planes dipping up-glacier. The Britannia Gletscher is not heavily crevassed, and one can walk over the greater part of it without encountering crevasses more than a foot or two (half a metre) in width at the surface. Only one moulin was observed by expedition members, at a high level on the glacier.

The largest spout encountered is shown in Figure 1. This occurred about 0·5 km. from the snout, on the eastern half of the glacier, and its direction followed the radial drainage pattern. It was observed to flow continuously for several days after it was discovered, and although there was presumably some diurnal variation in response to changes in ablation rate, this was not observed. The trajectory of the water gushing from the glacier indicates that the englacial stream rose through the glacier at an angle of about 30 degrees to the horizontal. It is unlikely that a crevasse would guide exit at this angle, and it is more likely that the feature controlling the upward flow of water is one of the shear surfaces described above.

Figure 2 shows a smaller spout near to the eastern side of the glacier, only a few hundred metres

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Fig. 1. Water-spout on the Britannia Gletscher, north-east Greenland. The radial surface drainage flows from right to left towards the glacier snout. The small scarps extending from the front of the figure towards the left rear are surface expressions of shear planes dipping up-glacier. The slope of these planes may control the trajectory of the water-spout

Fig. 2. Water-spout on the Britannia Gletscher, north-east Greenland. The water is gushing from a small opening which has migrated down the line of a closed crevasse, now marked by the narrow pool extending towards the front of the figure from the left hand of Mr. J. P. Masterton

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above the snout; lateral moraines are visible in the background, and in this area all surface streams flow directly towards them. The water here is gushing continuously from a small opening near the left hand of Mr. J. P. Masterton, with a trajectory directed towards the edge of the glacier. The small opening lies on the line of what had once been a crack, now apparently closed. The narrow pool extending towards the front of the figure marks the surface expression of the former crack, and the point of exit of the water appears to have migrated down this pool towards the edge of the glacier.

The water-spouts persisted for extended periods, indicating that the water followed reasonably permanent routes through the ice. I have no information about the duration of the water spouts beyond the "several days" already mentioned. Since the Britannia Gletscher has relatively few internal openings, there would be little opportunity for internally flowing water to transfer from one established route to another. These water-spouts appear to be exit points of an internal drainage pattern which approximately parallels the surface drainage pattern, and appears to remain fairly constant like many of the deeply incised surface channels.

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